COVID-19 ARIMA Model Forecast: Confirmed, Mortality & Recovered Cases in 13 Caribbean Countries

Debjyoti Talukdar, Dr. Vrijesh Tripathi

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Debjyoti Talukdar[1]; Dr. Vrijesh Tripathi[2]

[1]All Saints University School of Medicine Roseau DM
[2]University of West Indies of St. Augustine St. Augustine TT

Corresponding Author:
Debjyoti Talukdar
All Saints University School of Medicine
Hillsborough St. Roseau Dominica
Roseau
DM

Abstract

Background: Rapid spread of SARS nCoV-2 virus in Caribbean region has prompted heightened surveillance with more than 350,000 COVID-19 confirmed cases in 13 Caribbean countries namely Antigua and Barbados, Bahamas, Barbados, Cuba, Dominica, Dominican Republic, Grenada, Haiti, Jamaica, Saint Kitts and Nevis, Saint Lucia, Saint Vincent and the Grenadines, Trinidad and Tobago.

Objective: The aim of our study is to analyze the impact of coronavirus (SARS nCoV-2) in 13 Caribbean countries in terms of confirmed cases, number of deaths and recovered cases. Current and projected forecasts using advanced autoregressive integrated moving average (ARIMA) models will enable local health organisations to plan future courses of action in terms of lockdown and managing essential public services.

Methods: The study uses the auto regressive integrated moving average (ARIMA) model based upon time series pattern as per data retrieved from John Hopkins University, freely accessible on public domain and used for research and academic purposes. The data was analyzed using STATA 14 SE software between the time period - Jan 22, 2020 till May 27, 2020 using ARIMA time series analysis. It involves generalizing an autoregressive moving average model to better understand the data and predict future points in the time series until June 15, 2020.

Results: The results show the predicted trend in terms of COVID-19 confirmed, mortality and recovered cases for 13 Caribbean countries. The projected ARIMA model forecast for the time period - May 25, 2020 to May 31, 2020 show 20278 (95% CI 19433.21 - 21123.08) confirmed cases, 631 (95% CI 615.90 - 646.51) deaths and 11501 (95% CI 10912.45 - 12089) recovered cases related to SARS nCoV-2 virus. The final ARIMA model chosen for confirmed COVID-19 cases, number of deaths and recovered cases are ARIMA (4,2,2), ARIMA (2,1,2) and ARIMA (4,1,2) respectively. All chosen models were compared with other models in terms of various factors like AIC/BIC (Akaike Information Criterion/Bayesian Information Criterion), log likelihood, p-value significance, coefficient < 1 and 5% significance. The autocorrelation function (ACF) and partial autocorrelation function (PACF) graphs were plotted to reduce bias and select the best fitting model.

Conclusions: As per the results of the forecasted COVID-19 models, there is a steady rise in terms of confirmed, recovered and mortality cases during the time period March 1, 2020 until May 27, 2020. It shows an increasing trend for confirmed and recovered COVID-19 cases and slowing of the number of mortality cases over a period of time. The predicted model will help the local health administration to devise public policies in terms of awareness measures, lockdown and essential health services accordingly.

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COVID-19 ARIMA Model Forecast: Confirmed, Mortality & Recovered Cases in 13 Caribbean Countries

Debjyoti Talukdar[2], and Vrijesh Tripathi[1]

[1]Department of Mathematics & Statistics, The University of the West Indies, St.Augustine, Trinidad

[2]All Saints University School of Medicine, Roseau, Dominica

Corresponding Author:

Dr. Vrijesh Tripathi

Email: vrijesh.tripathi@sta.uwi.edu

Department of Mathematics & Statistics, The University of the West Indies, St.Augustine, Trinidad

Debjyoti Talukdar, Email: devndel@gmail.com, All Saints University School of Medicine, Roseau, Dominica

Abstract

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Conclusions: As per the results of the forecasted COVID-19 models, there is a steady rise in terms of confirmed, recovered and mortality cases during the time period March 1, 2020 until May 27, 2020. It shows an increasing trend for confirmed and recovered COVID-19 cases and slowing of the number of mortality cases over a period of time. The predicted model will help the local health administration to devise public policies in terms of awareness measures, lockdown and essential health services accordingly.

KEYWORDS

SARS nCoV-2; COVID-19; ARIMA Forecast; COVID-19 in Caribbean; Confirmed Cases; SARS nCoV-2 Mortality; Recovered COVID-19 Cases

Introduction

Background

As per WHO and CARPHA, the ongoing pandemic caused due to SARS nCoV-2 virus is a grave concern globally along with all member states of the Caribbean region including 13 countries namely Antigua and Barbados, Bahamas, Barbados, Cuba, Dominica, Dominican Republic, Grenada, Haiti, Jamaica, Saint Kitts and Nevis, Saint Lucia, Saint Vincent and the Grenadines, Trinidad and Tobago. The risk of transmission of the COVID-19 virus in Caribbean is high due to high inflow of tourists from around the world. The risk assessment level is based upon international guidelines as devised by WHO, PAHO, local health administration and other international organisations [1]. All member states of CARPHA are advised to increase surveillance mechanisms including random testing, lockdown measures, increase public awareness and implement national preparedness plans. Coronavirus task force and COVID-19 information centres were established in different regions to tackle the spread of the SARS nCoV-2 virus [2]. In order to assess the spread of the SARS nCoV-2 virus in the region, we intend to project a forecast in terms of confirmed cases, number of deaths and recovered cases in the Caribbean region.

Reputed medical organisations like PAHO based in Trinidad and Tobago, Barbados and Jamaica are collaborating with global organisations including WHO to intensify their preparation plans to respond against the current COVID-19 outbreak in Caribbean. They are also collaborating with the Ministry of Health of regional Caribbean countries to convey information in regard to latest developments, public health policies, lockdown measures, therapeutics and diagnostic modalities including an overview on rapid testing among vulnerable populations [3]. The growing COVID-19

pandemic globally has also impacted tourism and businesses in Caribbean with increasing COVID-19 confirmed cases and mortality over the period of time. Patients are also recovering slowly with regional and international health authorities assisting with infection control strategies, essential drugs and medical equipment supply and training of essential health care workers. The CARICOM along with its member states are working with chief medical officers and local health administrators of various Caribbean countries to set up COVID-19 testing facilities, quarantine zones and National Emergency Operations Center for daily COVID-19 briefings [4].

Our study focuses on predicting the trend of COVID-19 confirmed, mortality and recovered cases for 13 Caribbean countries. The data analysis involves ARIMA model which forecasts future values in a time series based upon its own past values, lags and forecast errors. The predicted forecast will be essential for CARPHA, PAHO and other regional health organisations in Caribbean to prepare themselves to handle the crisis and access risk in terms of community transmission from exported cases and coordinate regional preparedness with IMT and prepare travel guidelines and dissemination of information with media and local public. PAHO is also collaborating with regional governments and briefing updates with the Ministry of Health of various Caribbean countries in regard to public awareness, use of masks, maintaining social distancing and relaxing norms in a phased manner [5-7].

Increasing trend of COVID-19 cases in Caribbean region

As per our data analysis, it is seen that Dominican Republic out of all the 13 Caribbean countries possess the highest confirmed COVID-19 cases, followed by Cuba, Jamaica, Haiti, Trinidad and Tobago, Bahamas, Barbados, Antigua and Barbuda, Grenada, St. Lucia, St. Vincent and the Grenadines, Dominica, St. Kitts and Nevis. It also shows the significance of our study in order to predict future instances for Caribbean regions in order to devise policies for the public to follow health protocols and stop the transmission of SARS nCoV-2 virus in the community [7]. Similarly,

Caribbean countries with the highest number of mortality cases reported are - Dominican Republic, followed by Cuba, Haiti, Bahamas, Jamaica, Trinidad and Tobago, Barbados, Antigua and Barbuda. Moreover, as per our study, there is also an increasing trend for COVID-19 recovered cases in the Caribbean region. The highest number of recovered patients were from Dominican Republic, followed by Cuba, Trinidad and Tobago, Jamaica, Barbados, Bahamas, Haiti, St. Lucia, Antigua and Barbuda, Dominica, Grenada, St. Vincent and the Grenadines. Most importantly, our study demonstrates the future trend of COVID-19 crisis in Caribbean and its impact on health services and local communities. Our study can act as an essential resource for CARICOM and CARPHA member states as it shows the need for increased collaboration between various regional health authorities like PAHO and WHO with increased vigilance and exercising caution through public advisories, health protocols and pandemic countermeasures [9-11].

Methods

Data

The data for the STATA analysis is freely available for academic and research purposes through John Hopkins University GitHub Repository. It is collected and processed from accredited government sources like WHO, U.S CDC, DXY - one of the largest online communities for health care professionals, health institutions and medical researchers, European CDC, United States principal government health agencies and local health departments, media reports etc. The data is maintained by John Hopkins University in collaboration with CSSE and technical support from ESRI and John Hopkins University Physics Laboratory [12, 15]. The data include information in regard to COVID-19 Confirmed, Mortality and Recovered Cases from 13 Caribbean countries namely Antigua and Barbados, Bahamas, Barbados, Cuba, Dominica, Dominican Republic, Grenada, Haiti, Jamaica, Saint Kitts and Nevis, Saint Lucia, Saint Vincent and the Grenadines, Trinidad and Tobago. The time frame of the data starts from Jan 22, 2020 till May 27, 2020. Situation reports from WHO pertaining

to SARS nCoV-2 were published starting from Jan 21, 2020 [3].

Study Design and ARIMA Modelling

The data consist of time series patterns with information in regard to province/state, country, longitude, latitude and confirmed COVID-19 cases for each respective country. Similar time series data were provided for COVID-19 mortality and recovered cases respectively from Jan 22, 2020 till May 27, 2020. The data was compiled in an excel spreadsheet, merged using a ‘sum’ argument entered as formula for each specific date from Jan 22, 2020 till May 27, 2020. It was converted to .dta format for analysis using STATA 14 SE software ARIMA time series analysis. In order to declare the data as time series, the date variable was formatted using the STATA command ‘format’ and ‘%td’ in DDMMYYYY and quarterly format. It also involves STATA command ‘tsset’ which declares the data as time series over a period of time using lead and lag operators. Also, STATA command ‘tsfill’ was used to fill out the gaps in the time series model if there are any. Stationarity of the time series model was checked using STATAT ‘d’ differencing operator [13]. The differencing operator generates lags between current and previous values. The second order differencing was done using the ‘d2’ operator based upon the lag values of the first order differencing. Graphical representation of the first order and second order differencing was done using twoway line plots using STATA command ‘twoway’ and ‘tsline’ as shown in Figure 1. It is also very useful to check the stationarity of the time series using graphical plotting as second order differencing plots diminish around zero. These plots are essential to check the time series stationarity as they fit numerically on the x and y axis respectively.

Figure 1: 1st Order and 2nd Order Differencing for cumulative Confirmed, Mortality and Recovered COVID-19 Cases in 13 Caribbean Countries

COVID-19 Case Status	1st Order Differencing	2nd Order Differencing

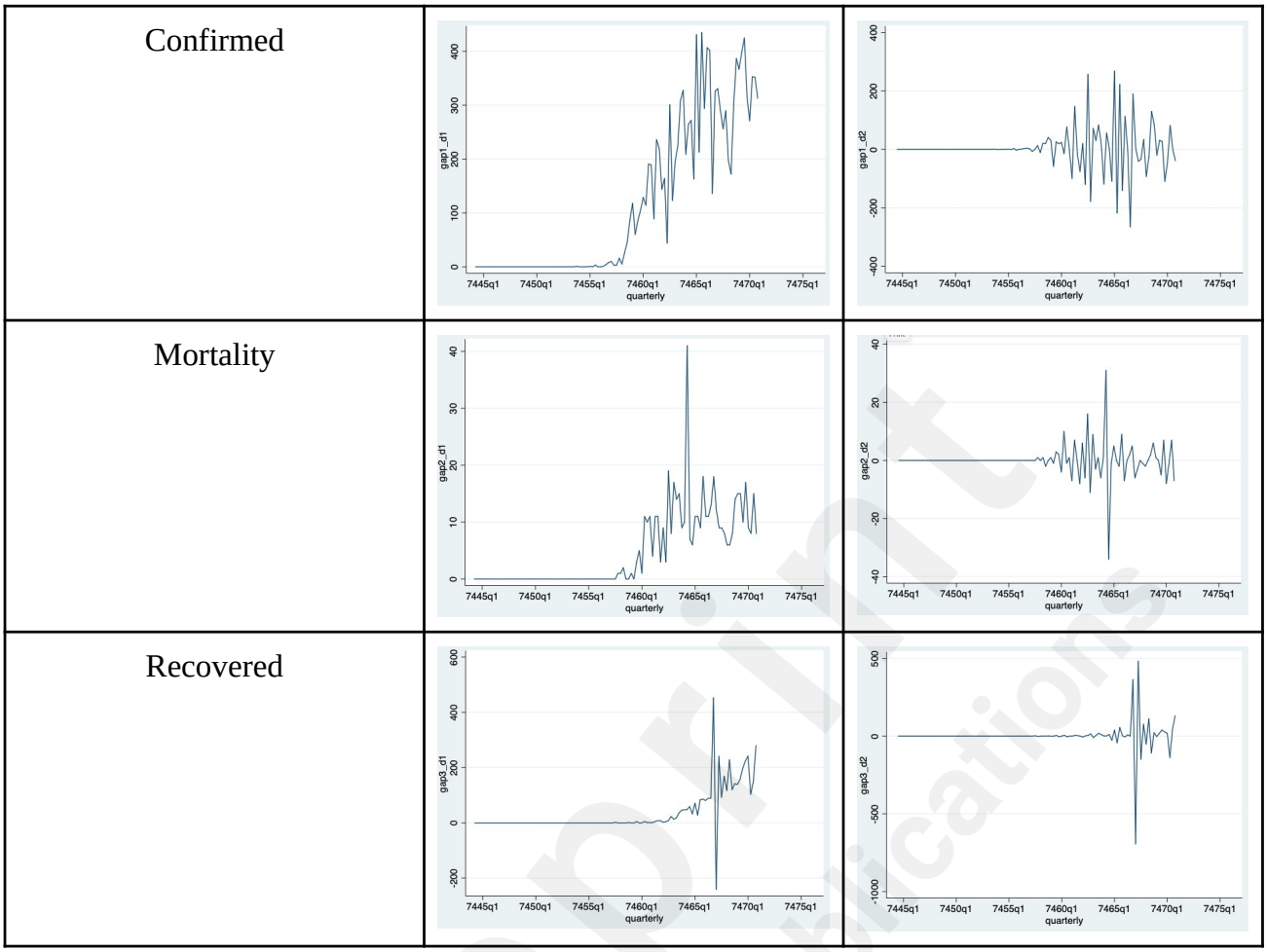
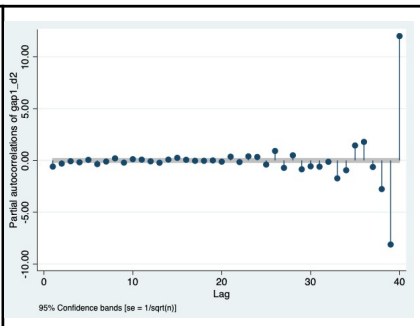
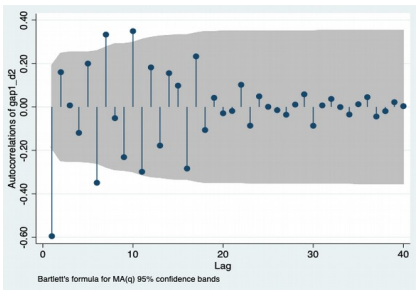
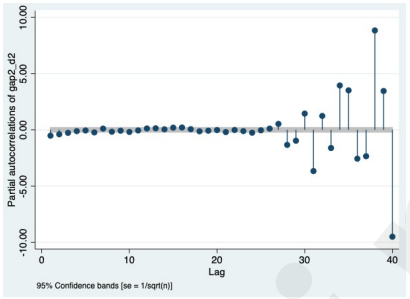
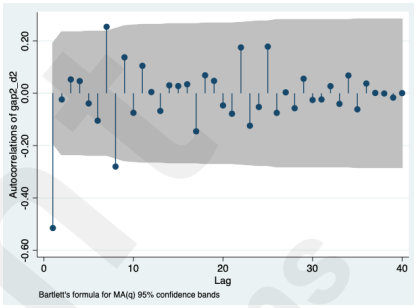
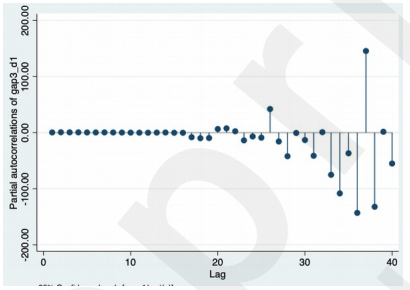
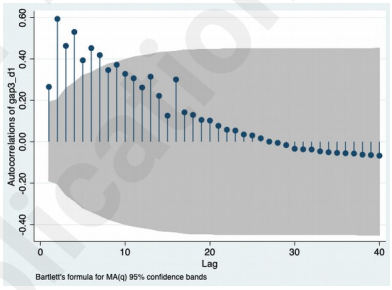


Figure 2: Forecasting Arima Models for 13 Caribbean Countries - Partial Autocorrelation Function (PACF) and Autocorrelation Function (ACF)

COVID-19 Status	Model	Partial Autocorrelation Function (PACF)	Autocorrelation Function (ACF)

Confirmed	ARIMA (1,2,1)		
Mortality	ARIMA (2,2,2)		
Recovery	ARIMA (4,1,2)		

Based on the graphical representation, the ARIMA model can be formed using ACF and PACF graphs using the STATA command ‘ac’ and ‘pac’ using first order differencing and second order differencing variables respectively as shown in Figure 2. ACF plots involve autocorrelation of prior values in a time series in various lags [14-15]. MA can be derived from ACF plots graphically which are involved in building ARIMA models for further analysis. In an ACF graph, the lines situated in the shaded region are within acceptable regions (95% CI) while the lines outside the shaded region are lags which are auto correlated in a series and the values are taken up as MA for ARIMA modelling. ACF plots are based upon Barlett’s formula for MA(q) processes involving pointwise confidence intervals. Similarly, PACF graphs are based upon selection of the partial autocorrelation in the selected time series. It involves a confidence interval calculated using standard error 1/ (root of n). The graph may also include residual variance for each lag. The values of AR are derived from

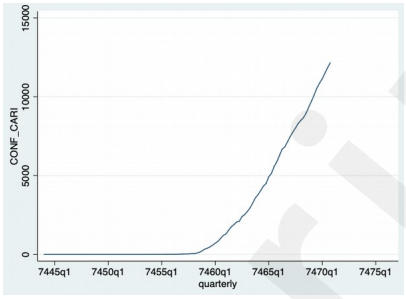
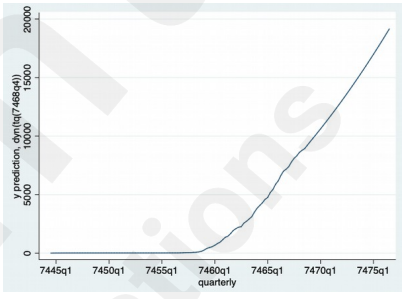
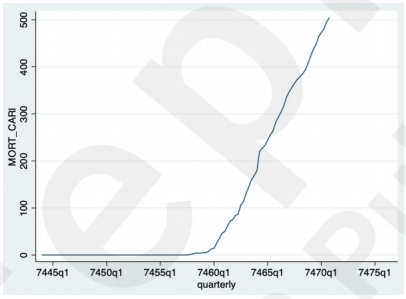
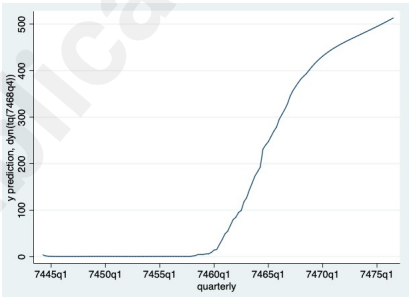
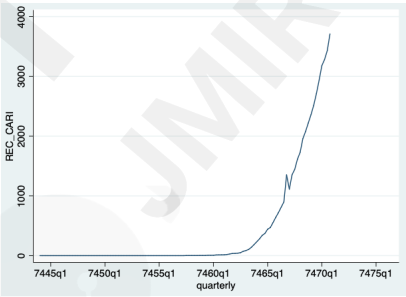
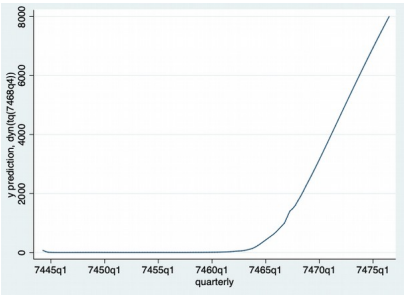
PACF graphs which can be used for ARIMA model forecasting. The value of I depends upon first order (I=1) or second order (1=2) differencing [16-19]. The models are chosen based upon smaller AIC/BIC values which indicates a better fitting model. Other features like log likelihood ratio, p-value significance and coefficient < 1 and 5% significance can also be checked to compare various models [25-26].

Results

As per results, data analysis with auto regressive integrated moving averages (ARIMA) modelling for 13 Caribbean countries shows 20278 (95% CI 19433.21 - 21123.08) confirmed cases, 631 (95% CI 615.90 - 646.51) deaths and 11501 (95% CI 10912.45 - 12089) recovered COVID-19 cases during the time frame - May 25, 2020 to May 31, 2020. Similarly, during the time period June 1, 2020 - June 7, 23328 (95% CI 22423.99 - 24232.98), 676 (95% CI 664.41 - 688.43) and 13607 (95% CI 13020.6 - 14194.66) confirmed, number of deaths and recovered COVID-19 cases are projected respectively overall as per STATA data analysis. Moreover, during the time frame - June 8, 2020 - June 15, 26832 (95% CI 25850.65 - 27812.76) cases are projected to be infected with SARS nCoV-2 virus in Caribbean region. The final ARIMA model chosen for confirmed COVID-19 cases, number of deaths and recovered cases are ARIMA (4,2,2), ARIMA (2,1,2) and ARIMA (4,1,2) respectively. These models were compared with other potential models such as ARIMA (1,1,2), ARIMA (4,2,1), ARIMA (3,1,3), ARIMA (1,1,4), ARIMA (3,1,5) etc in terms of AIC/BIC (Akaike Information Criterion/Bayesian Information Criterion), p-value significance, coefficient < 1 and 5% significance and log likelihood ratio. The AIC/BIC values for confirmed cases are reported as 1160.76 and 1171.42 respectively. The best fitting models in our study have the lowest A1C/BIC values in comparison to other potential models. The p-value is considered significant if it's less than 0.050 and more significant if it's less than 0.010. The AIC/BIC values for the number of deaths and recovered COVID-19 cases has AIC/BIC values - 619.46/635.44 and 1127.36/1143.4 respectively. The current

and projected trends are shown in Figure 3 for COVID-19 confirmed cases, number of deaths and recovered cases respectively.

Figure 3: COVID-19 Confirmed, Mortality & Recovered Cases Forecasting using Arima Models for 13 Caribbean Countries - Current Trend and Predicted Trend

COVID-19 Status	Model	Current Trend	Predicted Trend
Confirmed	ARIMA (4,2,2)		
Mortality	ARIMA (2,1,2)		
Recovery	ARIMA (4,1,2)		

Discussion

Principal Results

The projected ARIMA forecast show linear increase for COVID-19 confirmed cases along with increase in recovered patients over a period of time as per data gathered from 13 Caribbean countries

namely Antigua and Barbados, Bahamas, Barbados, Cuba, Dominica, Dominican Republic, Grenada, Haiti, Jamaica, Saint Kitts and Nevis, Saint Lucia, Saint Vincent and the Grenadines, Trinidad and Tobago respectively. The time series was checked for stationarity through first order and second order differencing along with the Dickey Fuller test. The results were graphically plotted using PACF and ACF to derive AR and MA for forecasting model building.

Table 1: Comparison of ARIMA Time Series Models for COVID-19 Confirmed, Mortality & Recovered Cases in 13 Caribbean Countries

CONFIRMED CASES						**FINAL MODEL**
Cons	**(1,1,1)**	**(2,1,1)**	**(5,1,3)**	**(3,1,3)**	**(3,1,1)**	**(1,2,1)**
L1.ar	0.99***	0.71***	-1.01***	-0.44***	0.77***	**-0.21***
L2.ar		0.27**	-0.44***	0.53***	0.26**	
L3.ar			0.74***	0.88***	-0.046	
L4.ar			1.00***			
L5.ar			0.57***			
L1.ma	-0.68***	-0.53***	1.33***	0.76	-0.58**	**-0.63*** **
L2.ma			1.37***	0.09		
L3.ma			0.44*	-0.64		
AIC	1180.23	1178.42	1172.82	1173.74	1180.36	**1160.76**
BIC	1190.92	1191.79	1199.54	1195.13	1196.41	**1171.42**
MORTALITY						**FINAL MODEL**
Cons	**(1,2,2)**	**(1,2,1)**	**(2,1,1)**	**(1,1,1)**	**(3,2,2)**	**(2,2,2)**
L1.ar	-0.91***	-0.12	0.85***	0.98***	-1.06***	**-1.04*** **
L2.ar			-0.13		-0.22	**-0.18***
L3.ar					-0.034	
L1.ma	0.23	-0.77***	-0.73***	-0.77***	0.186	**0.164**
L2.ma	-0.85***				-0.68***	**-0.69*** **
AIC	619.84	617.68	626.62	625.95	621.39	**619.46**
BIC	633.16	628.33	639.98	636.64	640.03	**635.44**
RECOVERY						**FINAL MODEL**
Cons	(4,1,2)	**(2,1,4)**	**(1,1,5)**	**(8,1,1)**	**(2,1,1)**	**(3,1,2)**
L1.ar	1.18***	1.96***	0.99***	0.38**	0.41***	**1.24*** **
L2.ar	0.21	-0.96***		0.53***	0.57***	**0.17**

L3.ar	-0.21			0.23		**-0.419*** **
L4.ar	-0.19			0.206		
L5.ar				-0.005		
L6.ar				0.067		
L7.ar				-0.089		
L8.ar				-0.335		
L1.ma	-1.91***	-8.46	-1.72***	-1.06***	-0.71***	**-1.9*** **
L2.ma	0.99***	17.46	1.04***			**1.0*** **
L3.ma		-14.04	-0.27			
L4.ma		3.91	-0.058			
L5.ma			0.21			
AIC	1125.93	1030.19	1134.18	1142.11	1156.11	**1127.36**
BIC	1144.64	1050.95	1152.89	1171.51	1169.47	**1143.4**
*p < 0.05 **p < 0.01 ***p < 0.001						

Data analysis for the time series model was checked for stationarity as shown in Figure 1 using STATA differencing operators and graphs were plotted along the axis for the time frame Jan 22, 2020 till June 15, 2020. Figure 2 shows ACF and PACF models for confirmed, number of deaths and recovered COVID-19 cases plotted to find the best fitting model based upon Bartlett's formula for MA(q) 95% CI bands. Figure 3 shows current and projected forecast trends for final COVID-19 selected models - confirmed cases ARIMA (4,2,2), number of deaths ARIMA (2,1,2) and recovered cases ARIMA (4,1,2) respectively. Table 1 offers comparison of various models along with p-value significance, AIC/BIC values etc. Table 2 displays the current and projected forecast for the Caribbean region in terms of confirmed, number of deaths and recovered COVID-19 cases.

Table 2: Prediction for daily mean COVID-19 Confirmed, Mortality & Recovered Cases from Jan 22, 2020 till June 15, 2020 for 13 Caribbean Countries using ARIMA Model with 95% CI

Date	**Confirmed**	**Mortality**	**Recovery**
	95% CI	**95% CI**	**95% CI**
Jan 22, 2020 - Jan 26, 2020	-	-	-
(Week 1)			
Jan 27, 2020 - Feb 2, 2020	-	-	-
(Week 2)			

Feb 3, 2020 - Feb 9, 2020	-	-	-
(Week 3)			
Feb 10, 2020 - Feb 16, 2020	-	-	-
(Week 4)			
Feb 17, 2020 - Feb 23, 2020	-	-	-
(Week 5)			
Feb 24, 2020 - March 1, 2020	0.14	-	-
(Week 6)	(-0.21 - 0.49)		
March 2, 2020 - March 8, 2020	1.85	-	-
(Week 7)	(0.50 - 3.21)		
March 9, 2020 - March 15, 2020	14.71	-	-
(Week 8)	(4.44 - 24.98)		
March 16, 2020 - March 22, 2020	127.57	2.85	2.28
(Week 9)	(26.63 - 228.51)	(1.13 - 4.58)	(1.83 - 2.73)
March 23, 2020 - March 29, 2020	744.85	20.85	9.0
(Week 10)	(473.56 - 1016.15)	(6.85 - 34.85)	(1.52 - 12.73)
March 30, 2020 - April 5, 2020	1862.57	76.42	32.71
(Week 11)	(1517.53 - 2207.61)	(59.53 - 93.32)	(21.25 - 44.17)
April 6, 2020 - April 12, 2020	3269.57	159.71	157.57
(Week 12)	(2742.33 - 3796.81)	(127.62 - 191.8)	(84.76 - 230.37)
April 13, 2020 - April 19, 2020	5227.85	256.85	506.28
(Week 13)	(4566.87 - 5888.83)	(234.14 - 279.57)	(376.59 - 635.97)
April 20, 2020 - April 26, 2020	7452.42	342.42	1226.85
(Week 14)	(6886.14 - 8018.71)	(319.06 - 365.78)	(954 - 1499.71)
April 27, 2020 - May 3, 2020	8877.75	391	1997.5
(Week 15)	(8276.85 - 9478.64)	(371.72 - 410.27)	(1667.41 - 2327.59)
May 4, 2020 - May 10, 2020	11911	492.14	3563.28
(Week 16)	(11138.55 - 12683.45)	(473.68 - 510.60)	(3101.03 - 4025.54)
May 11, 2020 - May 17, 2020	14500.29	550.28	5469.71
(Week 17)	(13808.87 - 15191.7)	(535.09 - 565.47)	(4468.71 - 6470.719)

May 18, 2020 - May 24, 2020	17324	590.57	9419.42
(Week 18)	(16501.21 - 18146.79)	(579.03 - 602.10)	(8787.72 - 10051.14)
Projected Forecast			
May 25, 2020 - May 31, 2020	20278.15	631.21	11500.72
(Week 19)	(19433.21 - 21123.08)	(615.90 - 646.51)	(10912.45 - 12089)
June 1, 2020 - June 7, 2020	23328.49	676.42	13607.63
(Week 20)	(22423.99 - 24232.98)	(664.41 - 688.43)	(13020.6 - 14194.66)
June 8, 2020 - June 15, 2020	26831.71	720.51	15723.06
(Week 21)	(25850.65 - 27812.76)	(708.68 - 732.35)	(15167.6 - 16278.52)

Limitations

The study was limited to COVID-19 Confirmed, Mortality & Recovered Cases from 13 Caribbean Countries namely Antigua and Barbados, Bahamas, Barbados, Cuba, Dominica, Dominican Republic, Grenada, Haiti, Jamaica, Saint Kitts and Nevis, Saint Lucia, Saint Vincent and the Grenadines, Trinidad and Tobago during the time period Jan 22, 2020 till June 15, 2020 in the Caribbean region. The data is available in a time series format under the filename - time_series_covid19_confirmed_global.csv, time_series_covid19_deaths_global.csv and time_series_covid19_recovered_global.csv as provided by John Hopkins University.

Comparison with Prior Work

As per study conducted by Andy Sumner, Chris Hoy et. al., 2020, the economic impact of COVID-19 will be drastic, specifically in Latin America and Caribbean (LAC) region with potential short term health and financial consequences. It shows the importance of modelling forecast to understand the current situation and extent of potential impact COVID-19 possess for Caribbean region. Moreover, it also discusses how forecast modelling can assist local governments in Caribbean region

and international community to formulate plans to tackle the ongoing situation [27]. Another study by Simbana-Rivera K, Gomez-Barreno L et. al., 2020 shows comparison analysis of COVID-19 among Latin America and Caribbean countries. It focuses on significant burden over countries due to SARS nCoV-2 pandemic. It also discusses the importance of formulating pandemic preparedness plans and following government norms such as social distancing and wearing masks in order to slow the spread of the virus among local communities [28]. Another study by Benvenuto D, Giovanetti M et. al., 2020 focuses on application of ARIMA modelling and its role in COVID-19 epidemic. As per its dataset, it shows future perspective and case definition of countries impacted with SARS nCoV-2 virus based upon autoregressive integrated moving average model. It also adds that various institutions will benefit out of this forecast as ARIMA modelling involves incidence descriptive analysis of data along with incidence forecast and overall trend analysis [29]. Another article by Dehesh T, Mardani-Fard HA et. al., 2020 shows the importance of prediction models and analyzing the trend of novel coronavirus as a global pandemic for various countries. The study also discusses ARIMA modelling and its importance in the healthcare industry to predict future trends [30]. Chintalapudi N, Battineni G et. al., 2020 recommends data driven model approach and highlights significance of government policies based upon forecasting and modelling which can help to reduce positive COVID-19 cases and increase overall recovery rate through self isolation and social distancing. It also discusses the role of ARIMA forecasting and prevalence of SARS nCoV-2 virus in Italy. Moreover, the study analyzes preventive measures advised by the government like hand washing, disinfection, wearing masks, travel restrictions and suspension of public gathering based upon modelling and forecast. The outburst of the global pandemic through SARS nCoV-2 virus can have severe economic implications for Caribbean region as it is significantly dependent upon tourism. With an increase in overall COVID-19 confirmed cases in 13 Caribbean countries, borders are sealed and lockdown imposed to restrict human-to-human transmission [31]. A study by Jenkins R, Peters ED et. al. discusses Caribbean trade relations with China in terms of foreign direct

investment and its impact on the economy. The far reaching consequences of the COVID-19 outbreak has significantly impacted Caribbean countries in terms of health and trade relations. As per numerous studies and preliminary analysis, it shows that Caribbean countries need assistance in terms of health care and infrastructure to uplift themselves from the current crisis [32]. Moreover, another study by Rodríguez-Morales AJ, MacGregor K, Kanagarajah S; 2020 on COVID-19 and its impact globally, discusses the importance of carefully assessing the situation based upon scientific knowledge sharing, coordinated efforts and research in understanding the emergence of the outbreak and predicting future trend and developing countermeasures to revamp and uplift Caribbean communities in the midst of COVID-19 crisis [33].

Conclusions

The outbreak of COVID-19 is a grave concern in Caribbean region specifically due to high risk of transmission among the local community. CARPHA has issued certain guidelines for its member states including 13 Caribbean countries based upon WHO recommendations as mentioned in our study. Our cumulative projected ARIMA model for COVID-19 positive patients, mortality and recovered cases in 13 Caribbean countries can offer an insight for the government and health organisations operating in the region to assess pandemic preparedness plans and revise risk levels based on current and forecasted trends. Moreover, the data analysis and results can assist the health and tourism industry to manage potential threats and plan ahead for economic implications and contingency plans. It will also assist local communities to be aware of the current status and prepare accordingly for the future while maintaining social distancing and being vigilant.

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Authors' Contributions

Debjyoti Talukdar: Investigation, Writing- Original draft preparation, Conceptualization, Methodology, Software, Visualization, Data curation

Dr. Vrijesh Tripathi: Supervision, Software, Validation, Writing- Reviewing and Editing, Visualization

Conflict of Interest

The authors declare that they have no conflict of interest.

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Abbreviations

SARS nCoV-2: Severe acute respiratory syndrome coronavirus 2

ARIMA: Auto regressive integrated moving average

COVID-19: Coronavirus disease of 2019

AIC/BIC: Akaike Information Criterion/Bayesian Information Criterion

ACF: autocorrelation function

PACF: partial autocorrelation function

CARPHA: Caribbean Public Health Agency

WHO: World Health Organisations

U.S CDC: United States Centers for Disease Control and Prevention

PAHO: Pan American Health Organization

CARICOM: Caribbean Community

IMT: Incident management team

MA: Moving average

CI: Confidence Interval

AR: Autoregression

CSSE: Center for System Science and Engineering

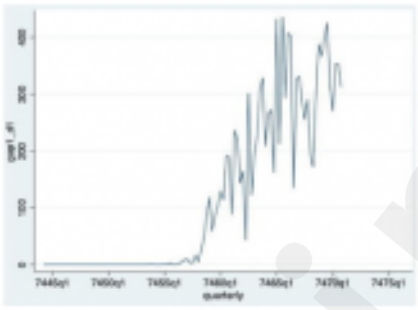
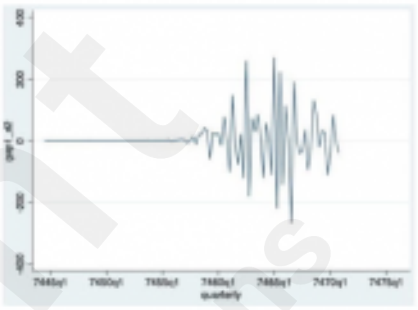
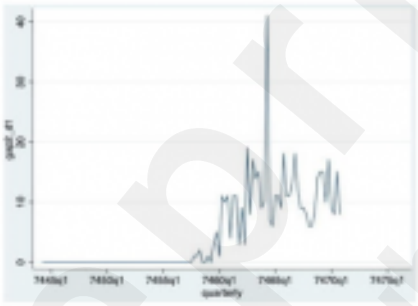
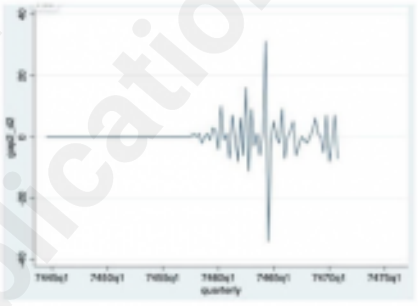
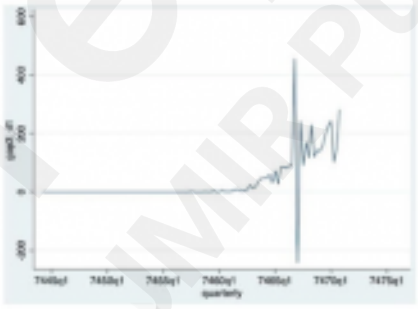
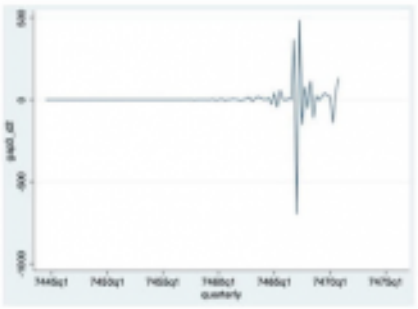
ESRI: Environmental Systems Research Institute

Supplementary Files

Figures

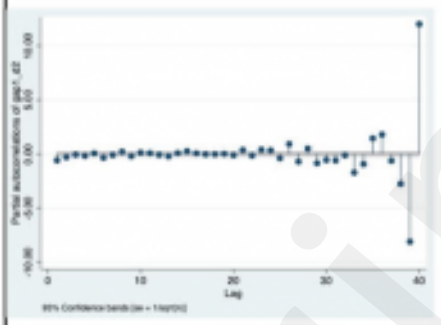
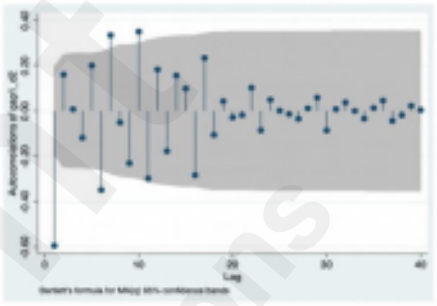
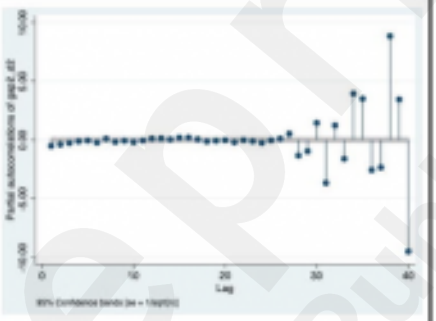
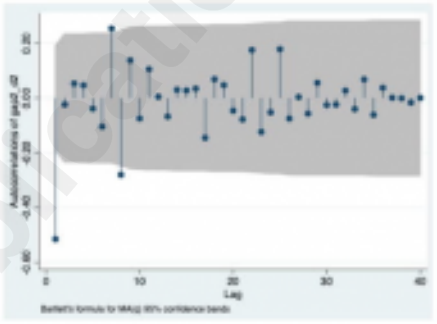
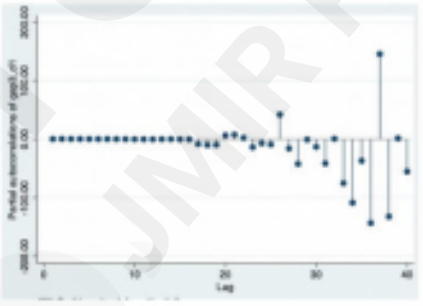
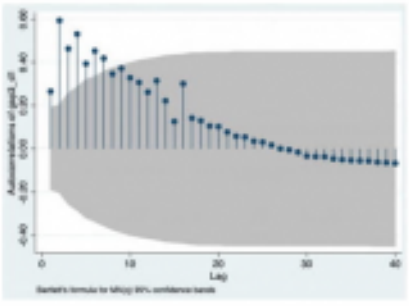
1st Order and 2nd Order Differencing for cumulative Confirmed, Mortality and Recovered COVID-19 Cases in 13 Caribbean Countries.

Figure 1: 1st Order and 2nd Order Differencing for cumulative Confirmed, Mortality and Recovered COVID-19 Cases in 13 Caribbean Countries

COVID-19 Case Status	1st Order Differencing	2nd Order Differencing
Confirmed		
Mortality		
Recovered		

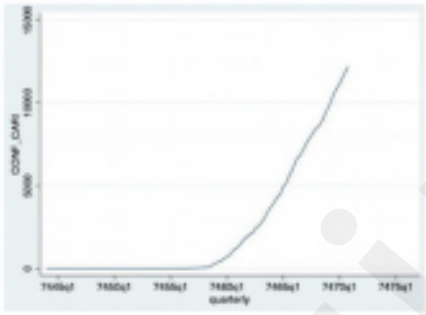
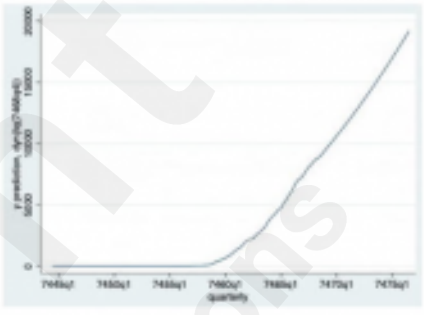
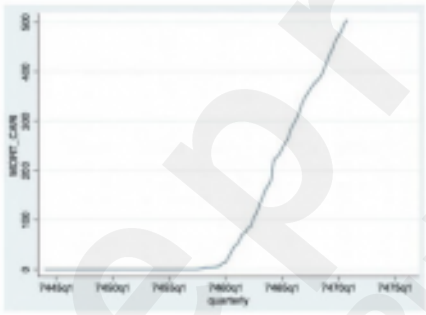
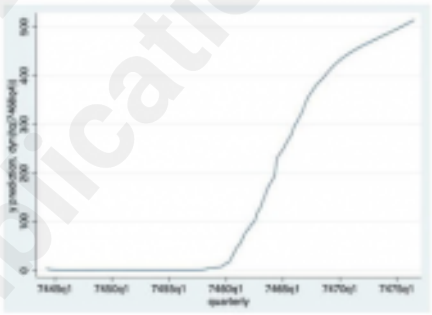
Forecasting Arima Models for 13 Caribbean Countries - Partial Autocorrelation Function (PACF) and Autocorrelation Function (ACF).

Figure 2: Forecasting Arima Models for 13 Caribbean Countries - Partial Autocorrelation Function (PACF) and Autocorrelation Function (ACF)

COVID-19 Status	Model	Partial Autocorrelation Function (PACF)	Autocorrelation Function (ACF)
Confirmed	ARIMA (1,2,1)		
Mortality	ARIMA (2,2,2)		
Recovery	ARIMA (4,1,2)		

COVID-19 Confirmed, Mortality & Recovered Cases Forecasting using Arima Models for 13 Caribbean Countries - Current Trend and Predicted Trend.

Figure 3: COVID-19 Confirmed, Mortality & Recovered Cases Forecasting using Arima Models for 13 Caribbean Countries - Current Trend and Predicted Trend

COVID-19 Status	Model	Current Trend	Predicted Trend
Confirmed	ARIMA (4,2,2)		
Mortality	ARIMA (2,1,2)		
Recovery	ARIMA (4,1,2)